PLEISTOCENE MOLLUSCAN FAUNAS OF THE NEWELL LAKE DEPOSIT, LOGAN COUNTY, OHIO

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INTRODUCTION

Nature and Purpose of Investigation

This report is primarily a paleoecological study of the molluscan fauna contained in the marl and peat deposits of Pleistocene Newell Lake. A detailed analysis of the fauna is made with special emphasis on the quantitative distribution of species to demonstrate changes in environment. It is hoped that this study, in conjunction with several others in progress, will prove useful in the establishment of faunal sequences which may be used in correlating Pleistocene nonmarine assemblages.

Location

The Newell Lake deposit is located in Union Township, Logan County, Ohio and lies in Section 11, Range 13, Township 4 (fig. 1) of the Between the Miamis district. The southeast corner of Section 11 is fixed at 40° 16' 34" North Latitude and 83° 48' 03" West Longitude. A buried kame field, composed of a complex of kames and associated gravel features, occupies an area of about thirty square miles southwest of Bellefontaine, Ohio. Till, varying in thickness from less than a foot to over 20 feet, covers the gravel (Forsyth, 1956, p. 137). It is in this buried kame field, between the Farmersville and West Liberty moraines, that the Newell Lake deposit is situated, six miles southwest of Bellefontaine and three miles northwest of West Liberty.

Access to the deposit may be gained by proceeding south from Bellefontaine on U. S. Route 68, a distance of 5 miles to Liberty Township Route 30, thence west two and one-quarter miles to a farm lane entering left onto the property of Mr. R. E. Starbuck. This lane proceeds south to the site of the present lake. Permission should be obtained before entering.

Methods of Investigation

In order to make quantitative determinations it was necessary to sample the Newell Lake deposit in successive two-inch layers throughout the vertical column. Several attempts were made before a station was located in which the rate of flow of ground water into the pit, as it was excavated, was sufficiently slow to maintain dryness by bailing. It was necessary to take three-inch samples in collections 20 through 24 because of the increased flow of ground water which finally terminated the sampling at that level. Sampling below collection 24 was accomplished through the use of a bayonet-type auger. These samples were utilized in the determination of the stratigraphy of the section below collection 24. Several other stations were sampled with the auger in order to outline the extent of the deposit and to establish several profiles.

Each sample at the chosen station measured 12 x 12 x 2 inches, except as noted above. The samples were placed in plastic bags, sealed, assigned a collection number and labeled. Samples in these bags maintain their moisture content indefinitely.

Due to the purity of the marl, soaking was not necessary prior to washing of the samples. The material from each collection was washed in a series of sieves from coarse to very fine. The residue was collected and placed on tables overnight to dry. This was collected when dry, placed in containers, and labeled.

The volume of the residue varied considerably (see fig. 2). In order to reduce the volume for study and to maintain a representative sample, each collection was separated into fractions by means of a Jones sample splitter. Different fractions were employed to facilitate sorting which were dependent upon the abundance of fossils in the particular collection (fig. 2). The total volume of each fraction was determined and portions of a fraction were ladled out at random,

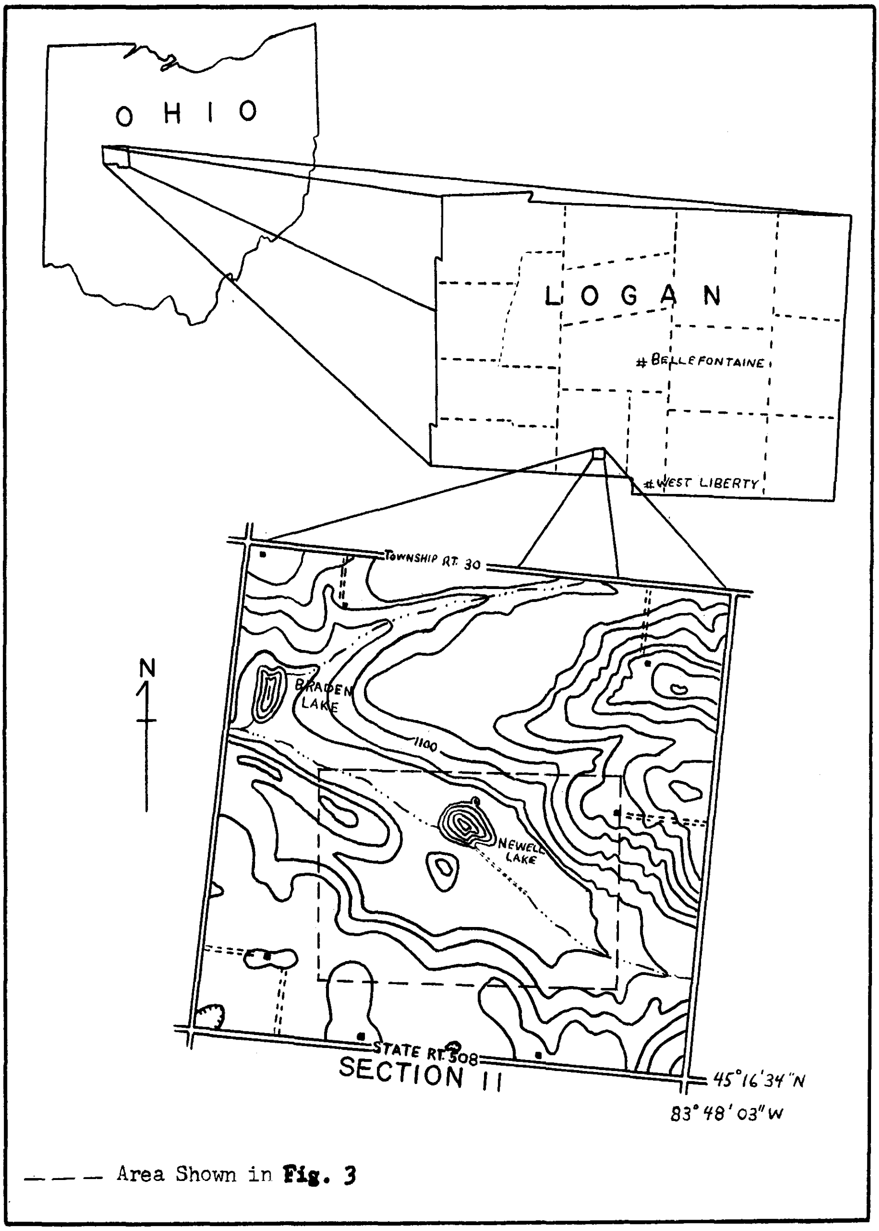

FIGURE 1. Index map showing the location of the Newell Lake area.

the volume also determined, and sorted until 1,000 shells were obtained. The volumes of the shells and of the residue were measured. From these data the total population of a given collection and the relative amount of vegetation (the residue consists primarily of shell fragments and vegetation) could be computed. The shells from each collection were later identified to genera and species. The percentage of each species was determined in each collection and also the volume of the total individuals in each collection (fig. 2). To evaluate the ecology, it is necessary to determine not only the specific assemblage but also the quantitative distribution of each species, the total volume of the population in each collection, and the relative amount of vegetation in each collection.

Coll. No.	Volume o. o. m.# in cc.	Volume of Mollusca in cc.	Total Mollusca
1	480	40	16,000
*2	704	1600	457,000
*3	704	2112	384,000
4	672	672	134,000
5	440	440	110,000
6	490	550	122,350
7	450	510	113,000
8	320	400	80,000
9	430	370	61,500
10	330	370	61,800
11	432	288	72,000
12	210	270	60,000
13	242	228	45,700
14	220	180	40,000
15	280	200	40,000
16	240	360	60,000
17	187	373	62,200
18	296	504	84,200
19	288	256	64,000
'20	180	300	60,000
'21	137	375	68,200
'22	107	213	53,300
'23	108	172	43,000

* Ratio of shell fragments to vegetation shows great excess over that of other collections.
' Collections are 3 inches thick; others are 2 inches thick.
o. o. m. - other organic material.

FIGURE 2. Vertical variation of Mollusca and other organic material in the Newell Lake deposit.

STRATIGRAPHY

Description of Deposit

Pleistocene Newell Lake lies at an elevation, determined along its perimeter, of 1077–1078 ft. It is 3000 ft long and averages 1200 ft in width, the longer axis extending northwest to southeast. On the west side, to the south of the outlet, there is a small esker (fig. 3) which is parallel to the long axis of the lake. A segment of this esker forms an island in the west central portion of the lake deposit. Bordering the center of the deposit, to the north and south, is a till covered outwash plain. Encompassing the southeast end of the deposit is a kame moraine. The lake deposits occupy a kettle hole amid the described surroundings.

Present day Newell Lake is situated at the northwest end of the deposit. It is at an elevation of 1075 ft. It measures 1000 ft in length, averages 500 ft in width, and reaches a depth of 18 ft near its center. The marl has been quarried from the north-central margin of the lake forming an embayment. A drainage ditch has been dredged to the southeast for a distance of 1100 ft which serves as an inlet fed by an intermittent stream to the southeast. A second intermittent stream enters from a small ravine to the northeast. A small alluvial fan has been deposited over the marl where the ravine opens out into the valley. The lake formerly drained by overflowing to the northwest along a narrow channel which connects with Braden Lake (fig. 1). At present the channel is filled with

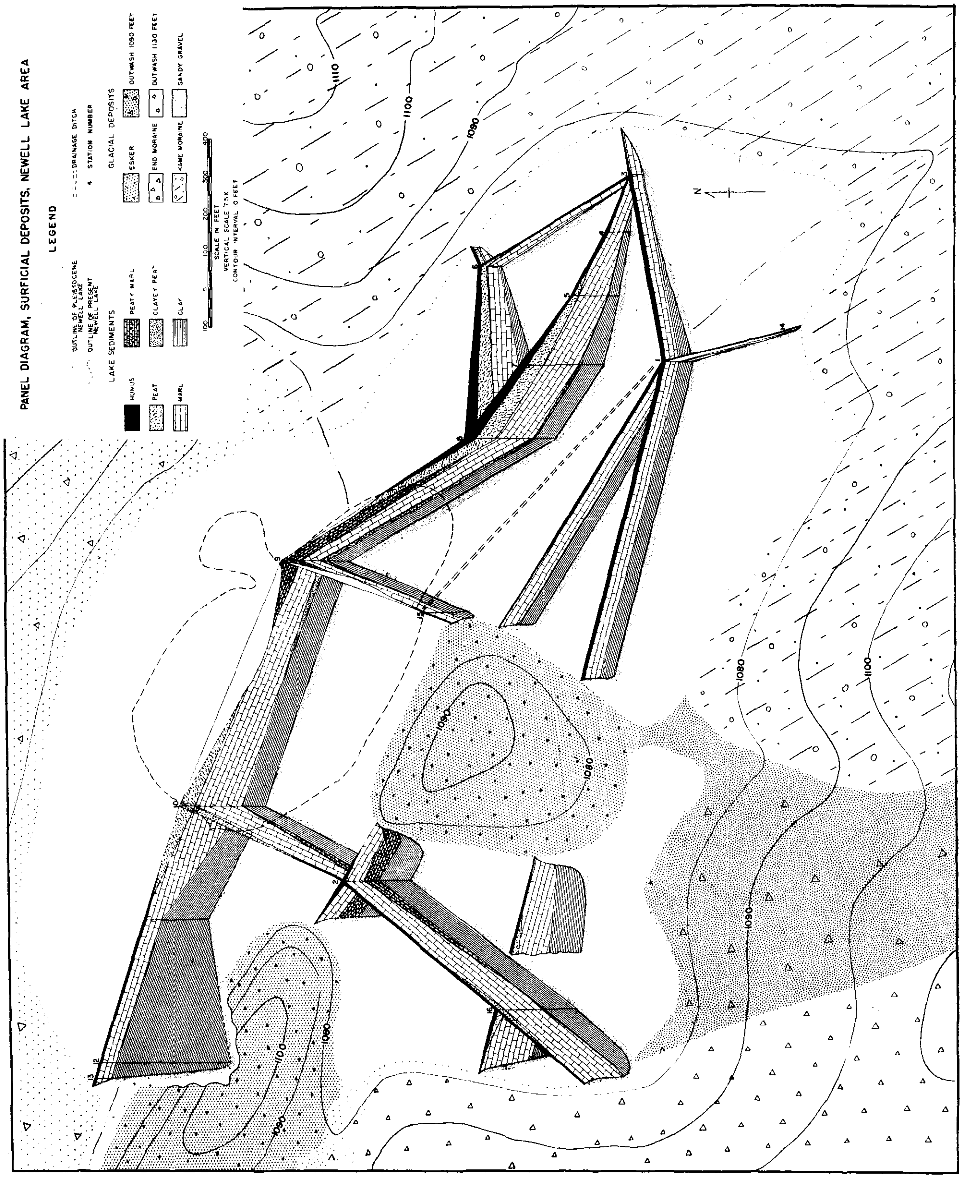

FIGURE 3. Panel diagram, surficial deposits, Newell Lake area.

sediment and drainage is accomplished by means of a tile drain set in the old channel. To the southwest of the present lake, at a distance of 1000 ft, is a swamp, the remnant of a shallow embayment of the once larger lake.

The marl ranges in thickness from a trace at the extreme margins to a maximum of 17 ft (see fig. 3). It is overlain throughout the deposit by a layer of brownish-black humus which averages 14 in. in thickness. Near the center of the main body of the deposit and near the center of the embayment to the southeast, a peat layer of varying thickness lies between the marl and the humus. At the same locations, a thin layer of peat 8 to 10 in. thick underlies the marl. Below the marl (or the peat layer as the case may be) is an olive gray clay which varies in thickness from a trace at the outer margins to a maximum of more than 40 ft. The clay rests throughout on a sandy gravel which could not be penetrated by the hand auger.

Both the overlying humus and the underlying olive gray clay are barren except in the southeast embayment area where the humus is fossiliferous. The marl is essentially pure (containing varying amounts of vegetation), pale yellowish brown, and highly fossiliferous. It changes in color downward to a light olive gray and the amount of vegetation and shells also decreases downward. There is a distinct break between the underlying clay, which is barren, and the overlying marl.

Measured Sections

These data for each section were obtained from the study of each core that was collected by means of the hand auger with the exception of Section 1 (see fig. 3 for location), which was collected from a hand excavated pit at two-in. intervals to a depth of 48 in., three-in. intervals from 48 to 60 in. Below the 60-in. level the remainder of the column was collected by means of the hand auger.

Colors and their corresponding designations were determined from the National Research Council Rock Color Chart. In each case the colors are those of the wet material.

The location of each measured section is indicated on figure 3 by a number at the top of each section.

Section No. 1

Unit	Description	Depth (inches)
1	Humus, compact, porous, noncalcareous, olive black (5Y 2/1), barren	0– 10
2	Humus, compact porous, noncalcareous, brownish black (5YR 2/1), fossiliferous inches 11–12. (Collection 1)	10– 12
3	Marl, fine, porous, moderately coherent, dark yellowish brown (10YR 4/2. Collection 2 and upper half of 3)	12– 15
4	Marl, fine, porous, slightly coherent, pale yellowish brown (10YR 6/2), increase in vegetation at inches 34–38. (Collections 3 through 23)	15– 51
5	Marl, very fine, compact, light olive gray (5Y 5/2) becoming firm and clayey near the bottom	51– 72
6	Clay, tight, plastic, olive gray (5Y 4/1), barren	72–132
7	Sand, coarse, and gravel	132–

Section No. 2

Unit	Description	Depth (inches)
1	Humus, compact, porous, noncalcareous, olive black (5Y 2/1), fossiliferous	0– 14
2	Marl, fine, porous, moderately coherent, pale yellowish brown (10YR 6/2)	14– 90
3	Marl, peaty, fine, porous, becoming compact near the bottom, dark yellowish brown (10YR 4/2) above, moderate brown (5YR 3/4) below	90–158
4	Clay, tight, plastic, olive gray (5Y 4/1), barren	158–290
5	Gravel, sandy	290–

Section No. 3

Unit	Description	Depth (inches)
1	Silt loam, loose, crumbly, yellowish brown (10YR 5/6)	0– 10
2	Marl, sandy, loose, somewhat friable, pale yellowish brown (10YR 6/2)	10– 61
3	Gravel, sandy	61–

Section No. 4

Unit	Description	Depth (inches)
1	Humus, compact, porous, noncalcareous, olive black (5Y 2/1), barren	0– 11
2	Marl, fine, porous, slightly coherent, pale yellowish brown (10YR 6/2)	11– 73
3	Clay, tight, plastic, olive gray (5Y 4/1), barren	73–116
4	Sand, coarse, and gravel	116–

Section No. 5

Unit	Description	Depth (inches)
1	Humus, compact, porous, noncalcareous, olive black (5Y 2/1), barren	0– 10
2	Peat, compact, blocky, olive black (5Y 2/1), becomes loose, porous, brownish black (5YR 2/1) toward the bottom	10– 36
3	Marl, fine, porous, slightly coherent, pale yellowish brown (10YR 6/2)	36–160
4	Clay, tight, plastic, olive gray (5Y 4/1), barren	160–207
5	Sand, coarse, and gravel	207–

Section No. 6

Unit	Description	Depth (inches)
1	Humus, compact, porous, noncalcareous, olive black (5Y 2/1), barren	0– 12
2	Peat, compact, blocky, olive black (5Y 2/1), becomes loose, porous, brownish black (5YR 2/1) toward the bottom	12– 34
3	Marl, fine, porous, slightly coherent, pale yellowish brown (10YR 6/2)	34– 90
4	Clay, tight, plastic, olive gray (5Y 4/1), barren	90– 97
5	Gravel, sandy	97–

Section No. 7

Unit	Description	Depth (inches)
1	Humus, compact, porous, noncalcareous, olive black (5Y 2/1), barren	0– 34
2	Peat, compact, blocky, olive black (5Y 2/1), becomes loose, porous, brownish black (5YR 2/1) at the bottom	34– 97
3	Marl, fine, porous, slightly coherent, pale yellowish brown (10YR 6/2)	97–253
4	Peat, clayey, compact, leathery, moderate brown (5YR 3/4)	253–259
5	Clay, tight, plastic, olive gray (5Y 4/1), barren	259–359
6	Gravel, sandy	359–

Section No. 8

Unit	Description	Depth (inches)
1	Humus, compact, porous, noncalcareous, olive black (5Y 2/1), barren	0– 48
2	Peat, compact, blocky, olive black (5Y 2/1), becomes loose, porous, brownish black (5YR 2/1) at the bottom	48–132
3	Marl, fine, porous, slightly coherent, pale yellowish brown (10YR 6/2)	132–288
4	Peat, clayey, compact, leathery, moderate brown (5YR 3/4)	288–296
5	Clay, tight, plastic, olive gray (5Y 4/1), barren	296–384
6	Gravel, sandy	384–

Section No. 9

Unit	Description	Depth (inches)
1	Peat, marly, loose, porous, dark yellowish brown (10YR 4/2)	0– 80
2	Marl, fine, porous, slightly coherent, pale yellowish brown (10YR 6/2)	80–240
3	Peat, clayey, compact, leathery, moderate brown (5YR 3/4)	240–270
4	Clay, tight, plastic, olive gray (5Y 4/1), barren	270–366
5	Gravel, sandy	366–

Section No. 10

Unit	Description	Depth (inches)
1	Peat, compact, blocky, olive black (5Y 2/1), becomes loose, porous, brownish black (5YR 2/1) at the bottom	0– 62
2	Marl, fine, porous, slightly coherent, pale yellowish brown (10YR 6/2)	62–264
3	Clay, tight, plastic, olive gray (5Y 4/1), barren	264–360
4	Gravel, sandy	360–

Section No. 11

Unit	Description	Depth (inches)
1	Humus, compact, crumbly, olive black (5Y 2/1), barren	0– 14
2	Marl, fine, loose, porous, pale yellowish brown (10YR 6/2)	14– 78
3	Clay, tight, plastic, olive gray (5Y 4/1), barren	78–276
4	Gravel, sandy	276–

Section No. 12

Unit	Description	Depth (inches)
1	Humus, compact, crumbly, olive black (5Y 2/1), barren	0– 8
2	Marl, fine, loose, porous, pale yellowish brown (10YR 6/2)	8– 74
3	Clay, tight, plastic, light olive gray (5Y 5/2) above, olive gray (5Y 4/1), barren	74–554

Section No. 13

Unit	Description	Depth (inches)
1	Humus, compact, crumbly, olive black (5Y 2/1), barren	0– 11
2	Marl, fine, porous, slightly coherent, pale yellowish brown (10YR 6/2)	11– 71
3	Clay, tight, plastic, olive gray (5Y 4/1), barren	71– 95
4	Sand, coarse	95–

Section No. 14

Unit	Description	Depth (inches)
1	Humus, compact, porous, noncalcareous, olive black (5Y 2/1), barren	0– 24
2	Marl, fine, porous, slightly coherent, pale yellowish brown (10YR 6/2)	24– 36
3	Clay, tight, plastic, olive gray (5Y 4/1), barren	36– 40
4	Sand, coarse, and gravel	40–

Section No. 15

Unit	Description	Depth (inches)
1	Humus, compact, porous, olive black (5Y 2/1), barren	0– 14
2	Marl, fine, porous, coherent, pale yellowish brown (10YR 6/2)	14– 92
3	Clay, tight, plastic, olive gray (5Y 4/1), barren	92–138
4	Gravel, sandy	138–

Section No. 16

Unit	Description	Depth (inches)
1	Humus, compact, porous, olive black (5Y 2/1), fossiliferous	0– 14
2	Peat, loose, porous, brownish black (5YR 2/1)	14– 24
3	Marl, fine, coherent, pale yellowish brown (10YR 6/2) becoming light olive gray (5Y 5/2) near the bottom	24–192
4	Peat, compact, leathery, moderate brown (5YR 3/4)	192–204
5	Clay, tight, plastic, olive gray (5Y 4/1), barren	204–342
6	Gravel, sandy	342–

QUANTITATIVE DISTRIBUTION

The Mollusca of the Newell Lake deposit are quite variably distributed. This distribution and its application to the interpretation of the paleoecology are important, especially when it is seen that there is basically very little change in the lithology of the fossil-bearing unit. For example, if one considers *Fossaria* *obrussa decampi*, it is seen that this species is present in each of the 23 collections. This much information may be interpreted to mean that the environmental conditions were of a nature suitable for the existence of this species throughout the section. However, the quantitative data show that the species was exceedingly limited in collection 23 upward to collection 11 and most likely was an intruder at that particular station. From collection 11 upward it is apparent that the conditions became much more favorable for it to thrive and it becomes indigenous.

This section will be devoted to the discussion of the quantitative distribution of each species. Interpretations will be made later under the discussion of the paleoecology.

A total of 38 species were collected from the Newell Lake deposit, of which 26 were recovered from the collections at Station 1, where quantitative data were obtained for every species represented with the exception of *Valvata sincera* which was recovered below the collections by means of the auger. Of the 26 species, the maximum number represented in any one collection is 21 and the minimum is 12. Ten species occur in every collection with one additional species persistent from collection 19 upward. The two species of Naiades are represented for the most part by fragments and quantitative data for these are, therefore, very limited.

A minimum of 15 species (including the Naiades) occurs from collection 11 upward.

List of Species Represented in the Newell Lake Deposit

Pelecypoda

Anodonta marginata Say
Lampsilis siliquoidea (Barnes)
Sphaerium lacustre (Müller)
Sphaerium sulcatum (Lamarck)
Pisidium casertanum (Poli)
Pisidium compressum Prime
Pisidium ferrugineum Prime
Pisidium nitidum nitidum Jenyns
Pisidium nitidum pauperculum (Sterki)
Pisidium obtusale rotundatum (Prime)

Freshwater Gastropoda

Valvata lewisi Currier
* *Valvata sincera* (Say)
* *Valvata tricarinata* (Say)
Amnicola leightoni F. C. Baker
Amnicola lustrica Pilsbry
Pomatiopsis cincinnatiensis (Lea)
Lymnaea stagnalis jugularis Say
Stagnicola umbrosa (Say)
Acella haldemani ('Deshayes' Binney)
Pseudosuccinea columella (Say)
Fossaria obrussa obrussa (Say)
Fossaria obrussa decampi (Streng)
* *Helisoma anceps striatum* (F. C. Baker)
* *Helisoma campanulatum* (Say)
Helisoma trivolvis (Say)
Planorbula armigera (Say)
Promenetus exacuous (Say)
Gyraulus altissimus (F. C. Baker)
Ferrissia parallela (Haldeman)
Physa gyrina Say
Physa sayii Tappan

Terrestrial Gastropoda

Stenotrema monodon (Rackett)
* *Hawaiia minuscula* (Binney)
Succinea ovalis Say
Oxyloma retusa (Lea)
Gastrocopta pentodon Say
Vertigo ovata (Say)
Vallonia pulchella (Müller)

*Species collected at Station 1.

The most significant species as to abundance are *Amnicola leightoni*, *Amnicola lustrica*, *Gyraulus altissimus*, and *Valvata tricarinata*. These four species comprise a minimum of 70 percent of the total individuals in each collection with the exception of collections 4 through 8 where their total decreases to 53 percent in collection 8. *V. tricarinata* (fig. 6) represents the greatest single occurrence by a species, comprising 51.5 percent of the total individuals in collection 23; it shows a gradual decrease upward to a minimum of 10 percent in collection 3. In comparison *G. altissimus* shows a gradual increase upward (fig. 14) to a maximum of 26.9 percent in collection 3. *Amnicola leightoni* and *A. lustrica* exhibit an overall decreasing trend upward (figs. 7 and 8) to collection 8, and then an overall increase upward from collection 7.

As discussed previously, *Fossarria obrussa decampi* is very limited in occurrence upward to collection 11. From collection 11 it shows a steady increase to a maximum of 21.5 percent in collection 7, followed by a steady decrease upward.

Six species are represented in several collections at least by more than one percent, but less than ten percent of the total individuals. Five of these: *Helisoma anceps striatum*, *Physa sayii*, *Promenetus exacuous*, *Pisidium ferrugineum*, and *Pisidium nitidum* are sufficiently abundant to be considered indigenous. Both *H. anceps striatum* and *Physa sayii* are present in all collections and show a relatively uniform distribution although *P. sayii* is somewhat more irregular in its distribution than *H. anceps striatum* (fig. 15 and 11). *Pisidium ferrugineum* and *P. nitidum* (fig. 4 and 5) exhibit erratic distribution. Both are exceedingly scarce in the lower collections but increase upward and become more numerous in collections 13 to 7. From collection 7 upward *P. ferrugineum* declines rapidly, whereas *P. nitidum* shows a decrease and then a sudden increase. *Promenetus exacuous* is present in all collections with the exception of 20 through 22. It shows a steady increase upward (fig. 13) from collection 18 to its maximum of 4.85 percent in collection 15; thereafter it shows a general decrease to a minimum of 0.1 percent in collection 2. The sixth species, *Helisoma campanulatum*, is present in all collections and is fairly uniform in its distribution (fig. 12); however, it is very limited in numbers and must be considered a marginal intruder, i.e. one whose habitat was not too far away from Station 1.

The remaining species at Station 1 are present in numbers that total less than one percent. All may be considered intruders with the exception of *Acella haldemani* (see p. 26).

The distributions just discussed are based upon the percentage of a species relative to the other species in a given collection. The true representation of the species must also include a consideration of the total number of that species in each collection. The total number is obtained by multiplying the total population of a given collection by the percentage, in that collection, of the species in question. For example, if we compare *V. tricarinata* in collections 23 through 21, it is seen, from figure 6, that there is a distinct decrease in percentage. By computing the total number of individuals in these collections, it is found that this species actually increased in absolute numbers.

PALEOECOLOGY

General Statement

The molluscan assemblage given on p. 20 is primarily a freshwater one and that of Station 1 is entirely freshwater. It is from these freshwater species and their relative abundance, that the environmental conditions and the changes in environment may be determined.

In order to understand the conclusions fully, data on the ecology are given for each species. In some cases the ecology must be inferred from related species or from other species that are considered synonymous. Vegetation, where given, refers to the shallow water communities which include the following: *Castalia*, *Chara*, *Dianthera*, *Lemna*, *Nymphaea*, *Pontederia*, *Potamogeton*, *Scirpus*, *Typha*, and *Vallisneria*. Data for pH and fixed carbon dioxide are quoted from Morrison (1932a). Food for the most part consists of diatoms, algae (commonly *Vaucheria*), other plankton, submerged vegetation, and bottom debris. The principal enemies are fish, and several of the species are infested by parasites.

Pelecypoda

Anodonta marginata *Say*.—This species is, for the most part, a mussel of lakes and is seldom found in rivers. It is found in shallow quiet lakes on mud bottoms, on exposed points, and in sheltered bays with sandy bouldery bottoms (Baker, 1918a, p. 166). It occurs in clear open waters, and among vegetation.

Morrison (1932a) observed that under extremely soft and acid water conditions, the shell developed is so thin that it may be twisted without cracking. It is impossible to twist the thicker shells developed under slightly alkaline conditions. Specimens taken from the lower peat layer of the Newell Lake deposit showed this pliable nature, whereas those taken from the marl were brittle.

Although the fragility of the species made it almost impossible to collect identifiable specimens, abundant fragments, two juvenile forms, and one identifiable adult were obtained from Station 1. Several additional specimens were collected from Station 2 a few of which were complete valves.

pH 6.03 to 8.37; fixed carbon dioxide 2.6 to 30.56 ppm.

Lampsilis siliquoidea (*Barnes*).—This species as stated by Ortmann (1919, p. 288) prefers rather quiet water and sandy-muddy bottoms. Strong currents and rough bottoms do not suit it although it is occasionally found in riffles. In such cases it has been washed out of the quieter pools. In the quiet water below riffles, where there is a more or less muddy bottom, or in slowly running water with fine gravel, sand and mud, it is abundant.

It occurs in lakes of all kinds, as well as in small and medium sized rivers; at depths of 0.2 m to greater than 30 m, more commonly from 1 to 2 m. It is generally found in clear water where vegetation is not abundant. All of the species of Lampsilinae, like the majority of species of the fresh water mussels, are limited to slightly alkaline water.

pH 6.9 to 8.14; fixed carbon dioxide 9.3 to 24.73 ppm.

Family Sphaeriidae.—The sphaeriids are quite variable and extremely difficult to identify to species. This situation has resulted, in many cases, in identification to genera only in the study of a particular fauna. The ecology of the species is therefore very limited. It is important to consider the ecology of the genera and supplement specific knowledge where it is available.

The sphaeriids live in all kinds of habitats. Many of them inhabit ponds or pools that dry up for a large part of the year. In these places, most of the animals die during the dry interval; a few survive by burrowing into the sand or deep into the mud bottom. The *Pisidia* often occur among vegetation. They occur in water of all depths. The adults bury themselves in the bottom but the young may be very active (Baker, 1928, p. 308). A great variety of bottom conditions are used; however, a firm bottom in which to burrow such as sand, mud, or clay, is preferred.

In the following discussion of the species, much of the ecology is drawn from one or more species, which are considered synonymous by Herrington (1954, p. 131–138) with the particular species under consideration. In each case the synonym is indicated.

Sphaerium lacustre (*Müller*).—This species inhabits shallow water among various bottom conditions from exposed gravel to fine deep mud. It prefers a firm bottom in water 0 to 0.6 m in depth. Baker (1928, p. 360) lists occurrences in the following environments: fine deep mud bottom, 0.6 m deep; hard clay bottom, 0.3 to 0.6 m deep; mud bottom, 0.5 m deep (*S. ryckholti*); pure hard packed sand (*S. jayense*). It has been recorded under swampy conditions among *Typha* and *Iris*.

pH 6.4 to 7.64; fixed carbon dioxide 9.3 to 18.87 ppm (*S. rosaceum*).

Sphaerium sulcatum (*Lamarck*).—This species belongs to eddies in streams and sometimes along the shores of lakes at a depth not much disturbed by wind action (van der Schalie, 1953, p. 85). It occurs on shallow bottoms of sand or gravel where there is a good current. Baker (1935) has collected it from the following environments: sandy silt or mud bottom, 1 m deep; sandy and rocky bottom with much debris. It is found among vegetation.

pH 6.9 to 8.37; fixed carbon dioxide 9.3 to 25.75 ppm.

Pisidium casertanum (*Poli*).—This species inhabits a sand or mud bottom, in shallow water, from 0.5 m to 3 m in depth. It occurs under swampy conditions or protected bays and has been collected by Baker (1916, 1918a, as *P. abditum*) from shallow water, with a sand, clay, or mud bottom, among vegetation. In Tomahawk Lake, Baker (1911a, *P. abditum*, *P. roperi*, and *P. subrotundatum*) records it from a swampy environment, among *Iris* and *Typha*. *P. abditum* was collected from soft sticky mud filled with algae.

pH 5.8 (*P. roperi*) to 7.95 (*P. strengi*); fixed carbon dioxide 5.5 (*P. roperi*) to 30.56 ppm (*P. strengi*).

Pisidium compressum *Prime*.—Baker (1928, p. 371) states "the typical form of *P. compressum* is confined principally to creeks and rivers." It is found on sandy, sandy silt, or mud bottom, in water 0 to 3 m deep among vegetation.

pH 7.0 to 8.37; fixed carbon dioxide 9.3 to 30.56 ppm.

Pisidium ferrugineum *Prime*.—Apparently an indigenous species in the upper collections of the Newell Lake deposit, *P. ferrugineum* inhabits mud, sand, or marly clay bottom in water 1 to 3 m deep, among vegetation, commonly *Vaucheria*.

pH 7.23 to 8.14; fixed carbon dioxide 10.8 to 12.5 ppm.

Coll. No.	No. of Individuals	Percent Total	Graphic Representation of Percent 2 4 6 8 10
1	1/2	0.06	
2	3/2	0.17	
3	1/2	0.05	
4	27/2	1.45	
5	23/2	1.38	
6	32/2	1.74	
7	93/2	5.32	
8	120/2	5.52	
9	99/2	5.40	
10	89/2	4.82	
11	59/2	3.10	
12	150/2	8.40	
13	74/2	3.99	
14	34/2	1.21	
15	16/2	0.82	
16	16/2	0.82	
17	20/2	1.02	
18	18/2	0.92	
19	54/2	2.79	
20	1/2	0.05	
21	1/2	0.05	
22	1/2	0.05	
23	2/2	0.10	

FIGURE 4. Quantitative distribution of *Pisidium ferrugineum* in the Newell Lake deposit.

Coll. No.	No. of Individuals	Percent Total	Graphic Representation of Percent 2 4 6 8 10
1	130/2	7.00	
2	107/2	5.66	
3	73/2	3.70	
4	79/2	4.24	
5	126/2	7.00	
6	124/2	6.76	
7	153/2	8.74	
8	128/2	6.02	
9	61/2	3.34	
10	61/2	3.30	
11	127/2	6.69	
12	101/2	5.52	
13	87/2	4.69	
14	35/2	1.76	
15	31/2	1.59	
16	33/2	1.69	
17	40/2	2.04	
18	23/2	1.27	
19	29/2	1.50	
20	13/2	0.66	
21	7/2	0.35	
22	7/2	0.35	
23	22/2	0.11	

FIGURE 5. Quantitative distribution of *Pisidium nitidum nitidum* in the Newell Lake deposit.

Pisidium nitidum *Jenyns*.—This species is the most abundant sphaeriid in the Newell Lake deposit. Like *P. ferrugineum* it is apparently indigenous in the upper collections. It inhabits shallow water 1 to 6 m deep, on sand, mud, or clay bottom, Baker (1928) lists the following occurrences: sand and mud bottom, 1.2 to 2.2 m (*P. minusculum*); mud bottom, 5.5 m, soft sand, shallow water (*P. splendidulum*); mud, 1.2 to 6.1 m, gravel 2.5 to 5.4 m, sand 0.3 to 0.8 m (*P. tenuissimum*).

pH 7.48 to 7.64 (*P. minusculum*); fixed carbon dioxide 12.96 to 18.87 ppm; pH 6.32 and fixed carbon dioxide 1.98 (*P. splendidulum*).

Pisidium nitidum pauperculum (*Sterki*).—This species is considered a distinct form of *P. nitidum* by Harrington (1954, p. 133). Its ecology may be considered essentially the same as *P. nitidum*. The following environments were noted by Baker (1928, p. 421): mud bottom, 1.5 to 1.7 m; mud bottom, 1.2 to 3.4 m; sandy mud bottoms 1 m; and a marly clay bottom, 10, 12.5, and 39.5 m (bleached shells).

pH 7.0 to 8.0; fixed carbon dioxide 9.3 to 24.73 ppm.

Pisidium obtusale rotundatum (*Prime*).—This species inhabits shallow ponds or lagoons, on mud or marly clay bottoms, in water that is shallow or moderately deep. The following environments are given by Baker (1928, p. 423–424): marly clay bottom, 9.5 to 11 m (*P. rotundatum*); mud bottom, 4.9 to 5.6 m; gravel bottom, 1.6 m; mud bottom, 9.5 m; sand bottom, 12 m (*P. vesiculare*).

pH 5.8 to 6.2; fixed carbon dioxide 1.97 to 9.0 ppm.

Freshwater Gastropoda

Valvata lewisi *Currier.*—This species inhabits ponds and lakes, especially the latter, living in water little more than one meter in depth, crawling on the mud or on aquatic vegetation (Leonard 1950, p. 11). It prefers shallow water with sand or silt bottom. Baker (1928, p. 28) notes that it is largely a lake species apparently not found in as deep water as *V. sincera.*

pH 7.35 to 7.7; fixed carbon dioxide 10.65 to 22.1 ppm.

Valvata sincera (*Say*).—Very little information is available on the ecology of this species. It is apparently a deep water form and occurs on gravel and mud bottoms. Baker (1916) did not list the species from Oneida Lake but further deep water dredging (1918a) produced *V. sincera,* which was most abundant in water 5 to 6 m deep. In Oneida Lake it seemed to be confined to water below 3 m. Robertson (1915) also recovered *V. sincera* from material dredged from a sandy bottom below 20 m. It seems to prefer coldwater lake habitats, with limited vegetation. It is recovered at present from the more northern lakes.

Coll. No.	No. of Individuals	Percent Total	10 20 30 40 50
1	262	28.3	
2	116	12.3	
3	98	10.0	
4	124	13.3	
5	166	18.4	
6	211	22.9	
7	148	16.9	
8	205	19.3	
9	245	26.8	
10	251	27.2	
11	256	27.0	
12	265	28.9	
13	305	32.9	
14	196	19.9	
15	220	22.6	
16	279	28.6	
17	301	30.6	
18	262	26.6	
19	285	29.4	
20	280	28.0	
21	353	35.3	
22	435	43.5	
23	500	51.5	

FIGURE 6. Quantitative distribution of *Valvata tricarinata* in the Newell Lake deposit.

Coll. No.	No. of Individuals	Percent Total	Graphic Representation of Percent 10 20 30 40 50
1	145	15.7	
2	165	17.5	
3	158	16.0	
4	119	12.8	
5	141	15.6	
6	109	11.9	
7	58	6.0	
8	68	6.5	
9	110	12.0	
10	124	13.4	
11	155	16.3	
12	106	11.6	
13	124	13.4	
14	225	22.6	
15	216	21.9	
16	165	16.9	
17	160	16.4	
18	185	18.8	
19	234	24.2	
20	190	19.1	
21	192	19.2	
22	179	17.9	
23	113	11.4	

FIGURE 7. Quantitative distribution of *Amnicola leightoni* in the Newell Lake deposit.

Beauchamp (1891, p. 52) states that *V. tricarinata* and *V. sincera* inhabit different haunts, eat different food, and if found together, it is in death rather than in life.

The Newell Lake specimens were recovered from auger samples taken in the section and at other sites. All were recovered from samples taken below eight feet.

The range of pH and fixed carbon dioxide may be inferred from its close relatives, *V. nylanderi* and *V. lewisi.* Morrison gives for *V. nylanderi* a pH of 7.6 and fixed carbon dioxide of 22.5 ppm (for *V. lewisi* see above).

Valvata tricarinata (*Say*).—Perhaps the most abundant of the fresh-water molluscs, this species is subject to considerable variation, especially in respect to carination. In discussing this form, the method proposed by La Rocque (1956) for designation of the variation is employed.

Valvata may be found under many varying conditions in streams and lakes. *V. tricarinata* is found from shallow water to depths exceeding 9 m. Baker (1928, p. 15) found that the strongly carinate form (111) is characteristic of rivers, whereas the variations 101 and 000 are confined chiefly to lakes. The relative distribution of these variations is shown in figure 16. It is evident from this figure, that the lake form 101, is most abundant throughout the section. *V. tricarinata* is the most dominant species in most of the collections, indicating that the environmental conditions must have been very favorable for it to flourish.

This species is abundant in weedy places on either sandy or muddy bottoms. None of the Valvatidae are found at a pH lower than 7.1 nor in water softer than that containing 8 ppm of fixed carbon dioxide. The ranges for *V. tricarinata* are: pH 7.16 to 8.37; fixed carbon dioxide 8.61 to 30.56 ppm.

Amnicola leightoni *F. C. Baker*.—This is an extinct species. It is necessary, therefore, to derive the ecology from *Amnicola limosa porata*, which is apparently the successor to *A. leightoni*.

A. limosa porata is the lake manifestation of *A. limosa*. It inhabits shallow water, ranging from swampy bays to sandy channels, but prefers protected muddy bays (Robertson, 1915). The following water depths and bottom conditions are listed by Baker (1928, p. 99–100): sand bottom, 0.3 m, vegetation; gravel, 0.3 m, vegetation; sand, 0.6 m, vegetation; boulder, 0.6 m, vegetation; gravel, 0.8 m vegetation; sandy silt, 0.9 m, vegetation; gravel in muck, 3.1 m. The presence of vegetation has been noted by Dennis (1928) as apparently the most important limiting factor in its environment. The depth of water and protection from exposure may be other limiting factors. Moffett (1943, p. 22) observed that *Amnicola* burrows beneath the sand during periods of storm. They are able to endure long periods without open water although moisture is necessary, but they may be virtually exterminated in their normal habitat by unusually high summer water temperatures.

Coll. No.	No. of Individuals	Percent Total	Graphic Representation of Percent 10 20 30 40 50
1	147	15.9	
2	264	28.0	
3	271	27.4	
4	261	27.9	
5	162	18.0	
6	108	11.8	
7	119	13.6	
8	113	11.1	
9	127	13.9	
10	140	15.2	
11	150	15.8	
12	187	20.4	
13	186	20.1	
14	298	30.0	
15	230	23.7	
16	263	26.9	
17	257	26.3	
18	309	31.5	
19	223	23.1	
20	370	37.1	
21	280	28.0	
22	245	24.5	
23	226	22.8	

FIGURE 8. Quantitative distribution of *Amnicola lustrica* in the Newell Lake deposit.

Coll. No.	No. of Individuals	Percent Total	Graphic Representation of Percent 0.2 0.4 0.6 0.8 1.0
1	0	0.00	
2	trace	0.00	
3	0	0.00	
4	0	0.00	
5	0	0.00	
6	0	0.00	
7	1	0.11	
8	4	0.37	
9	3	0.33	
10	8	0.83	
11	10	1.19	
12	3	0.33	
13	9	0.97	
14	8	0.80	
15	1	0.10	
16	1	0.10	
17	0	0.00	
18	0	0.00	
19	0	0.00	
20	0	0.00	
21	0	0.00	
22	2	0.20	
23	1	0.10	

FIGURE 9. Quantitative distribution of *Acella haldemani* in the Newell Lake deposit.

Its ability to withstand the more extreme conditions of pH and fixed carbon dioxide content is undoubtedly a contributing factor to its range and abundance within a particular deposit.

pH 5.68 to 8.37; fixed carbon dioxide 1.2 to 30.56 ppm.

Amnicola lustrica *Pilsbry*.—This species is usually an inhabitant of vegetation and is particularly abundant in filamentous algae (Baker, 1928, p. 106). It occurs in shallow water, 0 to 2 m deep, on sandy-silt or mud bottom, rarely on gravelly or bouldery bottoms. It lives mostly in protected bays, where vegetation is abundant.

The following values are given by Morrison for the variety *A. lustrica decepta*: pH 6.85 to to 8.37; fixed carbon dioxide 9.3 to 30.56 ppm. It may be inferred that values for *A. lustrica* fall in the general range of *A. lustrica decepta*.

Pomatiopsis cincinnatiensis (*Lea*).—This species is found on wet earth and roots of trees along the margins of small streams. It is distinctly an amphibious snail. Although it seemingly prefers wet ground to actual immersion in water, it is perfectly at home when submerged. It occurs in many places under leaves and on damp or wet mud in places more or less subject to overflow from streams and rivers. It is more tolerant of aquatic conditions than is *Succinea* (Berry 1943, p. 60). Leonard (1950, p. 13) notes that the snail is able to survive considerable periods of drought by closing the aperture tightly with the operculum.

Lymnaea stagnalis jugularis (*Say*) —Open swamps, or more or less stagnant parts of ponds or lakes, and rivers with abundant vegetation are the preferred habitats for this species. It may frequently be seen floating among pond-weeds and algae, or on floating logs. It lives on mud or sandy bottoms in shallow water, 0.5 to 1.5 m deep. A shore bordered with reeds and cattails is a favorite locality (Baker, 1911a). During periods of drought, *Lymnaea* will burrow into the sand or mud in an effort to survive.

Although it has primarily a diet of vegetation, as other molluscs, *L. stagnalis jugularis* has been seen to eat rotting vegetables and fruit, and is known to attack living animals, such as small fish.

pH 7.6 to 8.16; fixed carbon dioxide 15.8 to 23.0 ppm.

Stagnicola umbrosa (*Say*).—Baker (1928, p. 219) describes this species as an inhabitant of ponds and sloughs, which become more or less dry in the summer. It is abundant in pondlike areas where vegetation is thick. It is found on mud, silt, and clay at shallow depths of 0.3 to 1 m.

Much of the ecology of *S. umbrosa* may be inferred from *S. palustris elodes*, which is closely related. Baker (1928, p. 215) states ". . . (*S. palustris elodes*) is found plentifully in bodies of water of greater or less size, on floating sticks and submerged vegetation on stones and on the muddy bottom. Inhabits both clear and stagnant water, but prefers a habitat in which the water is not in motion. Seldom found out of the water. . . . The more distinctly malleated forms inhabit stagnant ponds where the bottom is muddy, with more or less decaying vegetation present. The food of *elodes* is made up of both animal and vegetable matter. . . ."

Morrison gives for *S. exilis*, a related species, these values: pH 5.9 to 7.74; fixed carbon dioxide 7.5 to 22.56 ppm. It may be inferred that *S. umbrosa* inhabits waters with similar but more restricted conditions.

Acella haldemani (*'Deshayes' Binney*).—The ecology of *A. haldemani* was for many years not completely understood. The fallacy that had done much to create a mystery in regard to *Acella* is the inference that it must migrate since only adult forms had been found. Dr. Reynold J. Kirtland (Baker, 1911b, p. 197) described it as a deep water species which migrates shoreward in the fall. In a more complete study of *Acella*, Morrison (1932b) recovered juvenile forms from the same places as the adults. He states that *Acella* does not migrate to deep water but remains in the zone of vegetation near shore at all times of the year and that when the vegetation has been killed down by winter conditions, the snags and logs serve as a substitute habitat on which to live and lay eggs. Studies of *Acella* in Ontario by Herrington (1947) revealed one colony in shallow water where there is no deep water for a half a mile; more conclusively, he found three juveniles in water 0 to 0.75 m in depth.

Baker (1928, p. 270) describes the species as an inhabitant of the larger lakes in more or less sheltered bays, always a protected habitat in water from 0.3 to over 1 m deep. In favorite habitat it forms colonies which cover several hundred yards, but the species is rarely found at any distance from the colony location. Dr. Kirtland noted that the location of the colony studied in Reed Lake near Grand Rapids, Michigan, did not vary a hundred feet in either direction over a ten year period. It is more sluggish in its movements than other Lymnaeidae. This slowness of motion will account, in part, for the colonial habits.

It dwells on a wide variety of vegetation, most commonly on the upper and lower sides of pond lily leaves and on floating or submerged vegetation. Variation in convexity of whorls and shape of the aperture shows that it has a correlation with the type of plant habitat. Narrow growth form, with flatsided whorls and proportionately narrower aperture, is produced when the individuals live on rushes, whereas a wider growth form, with slightly more convex whorls and a wider aperture is produced when *Acella* grows on other plants such as pond lilies burreed and pond-weed. (Morrison, 1932b).

A. haldemani is a sensitive and delicate species which occupies a rather restricted habitat of well-protected shallow water with abundant vegetation, along with a pH of 7.36 to 7.7 and a fixed carbon dioxide content of 17.0 to 22.56 ppm. Even in areas where the species thrives best it is found in very limited numbers. The delicacy or fragility of the shell, its restricted habitat, the paucity of individuals even under optimum conditions, and its colonial nature, produce a poor record for the species, especially the fossil record.

Pseudosuccinea columella (*Say*).—This species is an inhabitant of ponds and streams, where the water is more or less stagnant. A locality with an abundance of lily pads is a particularly favorable habitat. It is found also along the shore in shallow water, in the midst of cattails and other reeds. It is rarely found in running water. *P. columella* occurs in shallow bays and small ponds or creeks, where it browses in the pond scum and on bits of rotting stems of water plants. Baker has collected this species associated with *Lymnaea stagnalis jugularis, Fossaria obrussa*, and *Stagnicola palustris elodes*.

Coll. No.	No. of Individuals	Percent Total	Graphic Representation of Percent 10 20 30 40 50
1	57	6.1	
2	53	5.6	
3	88	8.9	
4	95	10.4	
5	121	13.4	
6	154	16.8	
7	188	21.5	
8	138	13.0	
9	106	11.6	
10	50	5.4	
11	42	4.0	
12	5	0.5	
13	8	0.9	
14	4	0.4	
15	1	0.1	
16	2	0.2	
17	2	0.2	
18	14	1.4	
19	54	5.6	
20	8	0.8	
21	trace	0.0	
22	2	0.2	
23	14	1.4	

FIGURE 10. Quantitative distribution of *Fossaria obrussa decampi* in the Newell Lake deposit.

Coll. No.	No. of Individuals	Percent Total	Graphic Representation of Percent 2 4 6 8 10
1	12	1.29	
2	20	2.12	
3	11	1.11	
4	41	4.40	
5	25	2.77	
6	23	2.51	
7	19	2.17	
8	23	2.16	
9	39	4.26	
10	28	3.03	
11	38	3.47	
12	21	2.30	
13	16	1.73	
14	33	3.32	
15	36	3.70	
16	26	2.66	
17	25	2.56	
18	27	2.75	
19	28	2.90	
20	17	1.71	
21	11	1.11	
22	6	0.60	
23	18	1.82	

FIGURE 11. Quantitative distribution of *Helisoma anceps striatum* in the Newell Lake deposit.

Fossaria obrussa obrussa (*Say*).—The normal habitat of this species is in small bodies of water, such as creeks, ponds, sloughs, bays, and marshy spots along river banks. It is at home on sticks, stones, and any other debris that may be in the water or along its edge (Baker, 1928, p. 293). It occurs in shallow water, 0 to 1 m deep, with soft mud bottoms or where there is accumulated vegetable debris, frequently in or on the border of swamps where the water is very quiet. Baker (1911b, p. 281) notes that it frequently inhabits quarries which are abandoned and filled with water.

pH 5.86 to 8.37; fixed carbon dioxide 1.26 to 25.75 ppm.

Fossaria obrussa decampi (*Streng*).—This species is very abundant as a Pleistocene fossil and no doubt lived with *Fossaria galbana*, an extinct species. *F. obrussa decampi* is rarer in the recent fauna, possibly another species approaching extinction (Baker, 1928, p. 301). This species is a form of small lakes. The ecology of this species is probably the same as that of *F. obrussa* and may be assumed to have the same diet and natural enemies. Baker (1935, p. 264) recovered *F. obrussa decampi* living on a sandy-silt bottom, in water two ft deep, among *Scirpus* and *Chara*.

For the genus *Fossaria*, Morrison (1932a) notes that the common species *F. obrussa* is found from pH 5.9 to 8.3 while the supposed ancestral form *F. obrussa decampi* is found under much more restricted conditions; which immediately raises the question as to which is the ancestral form and which is the special form found under a special set of conditions attendant upon recently formed glacial lakes.

pH 7.42 to 7.7; fixed carbon dioxide 10.65 to 18.87 ppm.

Helisoma anceps striatum (*F. C. Baker*).—Once considered extinct but now known from the more northern lakes, *H. anceps striatum* is usually found in shallow water among vegetation growing on a mud or clay bottom. It is similar to *H. anceps anceps* in its habitat and inferences may be made, to some extent, where the record is lacking. Baker's account (1935) of North Star Lake, Minnesota, lists *H. anceps striatum* in habitats generally 1 m deep, with sand or sandy silt to mud bottom, more or less protected, and with abundant vegetation.

This species is apparently indigenous in the section examined. Its distribution in the Newell Lake deposit closely parallels that of *Physa sayii*, both in total individuals and in comparative numbers of adult and juvenile forms.

pH 6.08 to 8.02; fixed carbon dioxide 2.66 to 30.56 ppm.

Coll. No.	No. of Individuals	Percent Total	Graphic Representation of Percent 2 4 6 8 10
1	trace	0.00	
2	2	0.21	
3	16	1.62	
4	1	0.11	
5	2	0.22	
6	7	0.76	
7	trace	0.00	
8	1	0.09	
9	6	0.66	
10	9	0.97	
11	7	0.74	
12	20	2.19	
13	6	0.65	
14	5	0.50	
15	13	1.34	
16	15	1.54	
17	11	1.15	
18	15	1.53	
19	3	0.31	
20	3	0.30	
21	2	0.20	
22	2	0.20	
23	2	0.22	

FIGURE 12. Quantitative distribution of *Helisoma campanulatum* in the Newell Lake deposit.

Coll. No.	No. of Individuals	Percent Total	Graphic Representation of Percent 2 4 6 8 10
1	3	0.32	
2	1	0.10	
3	2	0.20	
4	10	1.10	
5	10	1.10	
6	4	0.40	
7	1	0.11	
8	5	0.45	
9	5	0.54	
10	20	2.16	
11	26	2.73	
12	11	1.18	
13	20	2.15	
14	46	4.60	
15	47	4.85	
16	29	2.15	
17	29	2.95	
18	10	1.00	
19	3	0.30	
20	0	0.00	
21	0	0.00	
22	0	0.00	
23	4	0.40	

FIGURE 13. Quantitative distribution of *Promenetus exacuous* in the Newell Lake deposit.

Helisoma campanulatum (*Say*).—This species occurs in shallow water, exposed or protected, on a great variety of substrata, from bare rock bottom to deep mud. Robertson (1915, p. 100) found it in weedy places, both sandy and muddy, up to 6 m in depth. He describes it as not fitted for exposed situations because of the size and shape of its shell and the vertical position in which it is carried. Baker (1911b, p. 236), on the contrary, states that it apparently prefers a habitat where wave action is marked, on sandy or pebbly shores. From collections made by Baker (1916, 1935), *H. campanulatum* occupies the same habitats as *H. anceps striatum*, but in addition was found on boulder and pebble bottoms along exposed shores.

pH 6.6 to 8.16; fixed carbon dioxide 7.5 to 30.56 ppm.

Helisoma trivolvis (*Say*).—This species, according to Baker (1928, p. 332–333), is always an inhabitant of quiet, more or less stagnant water. It occurs along swampy shores, in marshes, or in stagnant pools, with mud or fine sandy-silt bottoms, up to 2 m in depth although generally in water less than 0.6 m deep. Robertson (1915) reports that it prefers shallow bays with comparatively high temperature.

It may be found on the under sides of lily leaves, on driftwood, or among dead vegetation. Leonard (1950) states that it is invariably absent from flowing streams and that its presence in an assemblage of fossils is a good indicator of the presence of ponded water, since the species is so restricted in its habitat.

pH 6.6 to 8.37; fixed carbon dioxide 7.5 to 30.56 ppm.

Planorbula armigera (*Say*).—This species is largely one of swales or of small and stagnant bodies of water (Baker 1928, p. 358). It prefers the quiet waters of small lakes or ponds where there is abundant vegetation and a mud or silt bottom 0 to 1 m in depth.

It is fairly active in woodland pools at the edges of marshes and in ditches and small streams. It is apparently capable of lying dormant in drier mud during the greater part of the year (Goodrich 1932, p. 67).

pH 6.6 to 7.6; fixed carbon dioxide 7.5 to 16.7 ppm.

Promenetus exacuous (*Say*).—This species is an inhabitant of quiet places on all varieties of bottom from 0.5 m to 5 m deep. It is most abundant on sand and mud bottoms in 0.6 m to 1.6 m of water. It is rare on a gravel bottom but may be common on a boulder bottom. It is listed by Baker (1928, p. 362–363) from soft, silty bottoms to sticky mud or on logs.

From studies made in the Bass Island Region, Lake Erie, Dennis (1928) concluded that temperature is apparently the most important factor in the distribution of *Promenetus* since it was found at only one station in water at 17° C which was lower than any of the other stations by 4° C. Vegetation is undoubtedly another important factor in its distribution. The presence of abundant vegetation would tend to lower the temperature on account of the shade afforded.

It commonly occurs in protected weedy places on driftwood, lily pads, and on dead leaves. Baker (1916) found it in shallow water, 0.5 m to 1 m deep, on a muddy bottom with accumulation of dead plant debris where it was common on dead *Typha* leaves.

pH 7.0 to 7.64; fixed carbon dioxide 9.3 to 22.5 ppm.

Gyraulus altissimus (*F. C. Baker*).—Since the species is considered extinct (Baker lists it as living in southern Saskatchewan; see Russell 1934), no precise ecological data can be given except by inference from its related forms. La Rocque (1952, p. 15) drew inferences from its close relative *G. arcticus*. Morrison (1932a) showed that in the subgenus *Torquis* a marked series occurs consisting of *G. circumstriatus*, *G. parvus* and *G. arcticus*, in which a direct relationship of carination to acidity was revealed. A similar relationship was observed for *G. deflectus*, *G. obliquus*, and *G. hirsutus*, of the subgenus *Gyraulus sensu stricto*. From the examination of several representative faunas similar in composition to that of Newell Lake, it was observed that *G. parvus* occurred with *G. deflectus* or *G. obliquus*, and that *G. hirsutus* occurred with *G. arcticus*. It was also noted that, although no pH values were given, the stations from which *G. arcticus* were obtained showed environments that could be expected to be more alkaline. Comparison of faunas from several marl deposits revealed *G. altissimus* occurring most often with *G. deflectus*. The typical *G. altissimus* in the Newell Lake deposit shows development of carination, especially in the more adult forms. Since, as Baker (1928, p. 383) states, *G. altissimus* takes the place of *G. parvus* in most marl deposits, and based on consideration of the comparisons made above, *G. parvus* appears to be more closely associated with *G. altissimus* in regard to environment and distribution. The following ecology is, therefore, drawn from *G. parvus*.

G. altissimus most likely inhabited quiet bodies of water of small size, protected, with sandy silt, sandy mud, mud, or muck bottom; in water ranging from 0.5 m to 2.2 m in depth, and partial to a habitat which had rather thick vegetation. Dennis (1928) found that depth of water is apparently a limiting factor since it is always found in shallow water or on vegetation near the surface. It is always in protected places. The important limiting factors, therefore, are wave action and vegetation.

pH 7.0 to 8.16; fixed carbon dioxide 8.16 to 30.56 ppm.

Ferrissia parallela (*Haldeman*).—Baker (1928, p. 397) describes this species as an inhabitant of quiet water, on plants and the shells of Naiades, in shallow water, from 0.3 m to 2 m deep. It is commonly found near the water's edge. The animal occurs usually near the surface on the under-side of lily leaves, or on sticks. The presence of vegetation, as noted by Dennis (1928, p. 29), seems to be an important factor in the distribution of *F. parallela*. Lack of wave action is undoubtedly a factor, since they are found only in quiet, protected waters.

Johnson (1904) has described one method of distribution of the Ancylidae in which the animal attaches to the wing of water beetles and may become widely distributed.

pH 6.05 to 8.37; fixed carbon dioxide 2.75 to 25.75 ppm.

Physa gyrina *Say*.—This species appears to be characteristic of swamps and slow moving stagnant bodies of shallow water, usually on a mud bottom. It has been found in overflows from large rivers, in small ponds, behind river and lake beaches (Baker 1928, p. 451–452). It occurs on rock bottom, sand, sandy silt, and mud, in water 0.1 to 1 m deep, among vegetation.

pH 7.1 to 8.37; fixed carbon dioxide 9.5 to 25.75 ppm.

Physa sayii sayii (*Tappan*).—Although much detailed information is available concerning the genus *Physa*, very little is actually given for the exact ecology of *P. sayii*. From its close relation to *P. warreniana*, inferences as to its ecology may be made.

In general, still water offers much more favorable conditions for *Physa* than does flowing water. In the littoral zone, *Physa* is found even in unprotected places. Dawson (1911) lists the optimum environmental conditions as shallow water; minimum amount of shade; few or no enemies; minimum amount of debris; protection from waves or currents; moderate amount of water weeds and well-aerated water.

Decaying vegetation takes up oxygen and liberated carbonic acid. Under such conditions few *Physa* occur. If *Physa* is to inhabit lakes or ponds in any numbers it can do so only when, by some means or other, the growth of the pond weed is checked.

Coll. No.	No. of Individuals	Percent Total	10 20 30 40 50
1	212	22.9	
2	225	23.8	
3	266	26.9	
4	143	15.4	
5	161	17.8	
6	196	21.4	
7	203	23.2	
8	182	17.1	
9	168	18.4	
10	182	19.8	
11	137	14.4	
12	131	14.3	
13	146	15.7	
14	112	11.2	
15	107	11.0	
16	132	13.5	
17	122	12.4	
18	95	9.9	
19	85	8.8	
20	84	8.4	
21	126	12.6	
22	118	11.8	
23	92	9.3	

FIGURE 14. Quantitative distribution of *Gyraulus altissimus* in the Newell Lake deposit.

Coll. No.	No. of Individuals	Percent Total	Graphic Representation of Percent 2 4 6 8 10
1	13	1.40	
2	28	2.96	
3	28	2.84	
4	77	8.26	
5	33	3.66	
6	29	3.16	
7	13	1.48	
8	23	2.26	
9	29	3.17	
10	29	3.14	
11	49	5.15	
12	55	6.00	
13	37	3.99	
14	40	4.02	
15	75	7.54	
16	45	4.60	
17	48	4.90	
18	44	4.47	
19	19	1.96	
20	35	3.21	
21	30	3.00	
22	6	0.60	
23	8	0.80	

FIGURE 15. Quantitative distribution of *Physa sayii* in the Newell Lake deposit.

The habitat of *P. warreniana* is near shore in shallow water, ranging from bouldery exposed points to protected bays filled with vegetation. Baker (1928, p. 432) lists the following conditions under which *P. sayii* has been found: rocky bottom, shallow water; sand with vegetation, 0.6 m deep; gravel, 0.8 m deep; sand bottom, 0.3 m deep; mud bottom, 3.7 to 5.5 m deep, boulder bottom, 0.5 m deep.

Unlike many *Physa*, which are more commonly river or stream inhabitants, living in or near moving water, *P. sayii* apparently prefers a shallow, more protected environment such as is provided by sheltered small lakes or by embayments in larger lakes. The species does thrive, however, along beaches and Clench (1925) has collected specimens from aquatic plants in water 20 to 25 ft deep.

pH 5.68 to 7.96; fixed carbon dioxide 1.2 to 22.5 ppm.

Terrestrial Gastropoda

Stenotrema monodon (*Rackett*).—This species is a woodland snail usually found in moist situations. It thrives best on leaves or near old stumps or logs among trees. Although not a colonial species, it is often numerous at a favorite site (Leonard and Goble 1952, p. 1039). Archer (1948, p. 57) states that it lives in marshes and wooded swamps along banks of streams, on river plains and shores of lakes and ravines adjacent to rivers. It is also present in tall grass prairies, in open fields. It may be found on low terraces and flood plains under leaves, logs and stones.

Hawaiia minuscula (*Binney*).—This species is an inhabitant of humid situations where it lies in leaf mold or beneath the bark of trees, among mosses and beneath fallen logs, or beneath stones. In spite of its habitat preferences, it is capable of withstanding long periods of drought and high temperatures. It prefers a woodland environment in loose moist soil under a light layer of decaying vegetation, under leaves, among grass roots and under decaying logs (Leonard 1950, p. 36).

Alive, it is to be found rarely in numbers greater than four or five individuals, normally by the borders of streams and lakes, but it is one of the commonest shells of stream drift (Goodrich 1932, p. 33).

Coll. No.	Variation					
	111	101	100	110	001	000
1	39	175	45	1	2	0
2	10	76	30	0	0	0
3	2	48	48	0	0	0
4	7	97	27	0	0	0
5	4	153	9	0	0	0
6	3	201	7	0	0	0
7	7	139	0	0	0	0
8	8	197	3	0	0	0
9	27	215	1	0	0	0
10	19	231	5	0	0	0
11	10	241	2	0	0	0
12	30	233	0	0	0	0
13	37	268	0	0	0	0
14	25	171	0	0	0	0
15	27	193	0	0	0	0
16	30	249	0	0	0	0
17	28	273	0	0	0	0
18	21	241	0	0	0	0
19	12	273	0	0	0	0
20	10	270	0	0	0	0
21	14	339	0	0	0	0
22	22	413	0	0	0	0
23	15	482	2	0	0	1

FIGURE 16. Variation in the carination of *Valvata tricarinata*.

Succinea ovalis *Say*.—This species is an inhabitant of moist situations near ponds, swamps, and streams, often among trees or shrubs. It is abundant along the flood plain of the Missouri River where it lives among the grasses and sedges on mud flats, but it often ascends the wooded bluffs where moisture is abundant. Its preference for the moist environments is so characteristic that its distribution on a wooded slope may be suddenly truncated above a horizon where contact springs emerge (Leonard 1950, p. 24).

Goodrich (1932, p. 39) states, "The snail prefers drier localities than those frequented by *O. retusa* and often is to be found among the weeds of the edges of upland pools. In wet seasons it has been seen ten or twelve feet above the ground upon the trunks of smooth-barked trees."

Oxyloma retusa (*Lea*).—This species occurs in marshes and other wet places. It can be found upon partly submerged sticks, on rotting water weeds and often high on the stems of cattails. Frequently, it is in the company of *Lymnaea* (Goodrich 1932, p. 38). It has been collected by Baker (1935) from grass covered shores a few feet above the water line on pieces of bark and wood, and from pond lily leaves in a community of *Nymphaea* and *Castalia*. It commonly occurs on mud flats above the high water level along swampy shores caused by the raising of the water level in a lake or pond.

Gastrocopta pentodon (*Say*).—This species inhabits moist places under logs and stones on wooded slopes and poorly drained flood plains and among grass roots on open slopes. Leonard and Goble (1932, p. 1083) noted that it occurs abundantly on the drier west and south facing hillsides than on the north facing slopes. It is found on the forest floor among deep layers of leaf mold or under wet pieces of bark and on fallen trees.

Vertigo ovata (*Say*).—This species is also an inhabitant of moist places, being found among vegetation in swampy areas and along stream banks and other bodies of water. A limiting factor seems to be moisture (Leonard and Goble 1952, p. 1034).

Franzen and Leonard (1947, p. 355) state, "*Vertigo ovata* although found in various parts of the state (Kansas), lives only in moist environs afforded by shaded slopes near streams and shores of ponds. . . . In these regions are local ponds and streams, many of which are fed by artesian springs along whose shaded slopes *V. ovata* is found, though not in great numbers."

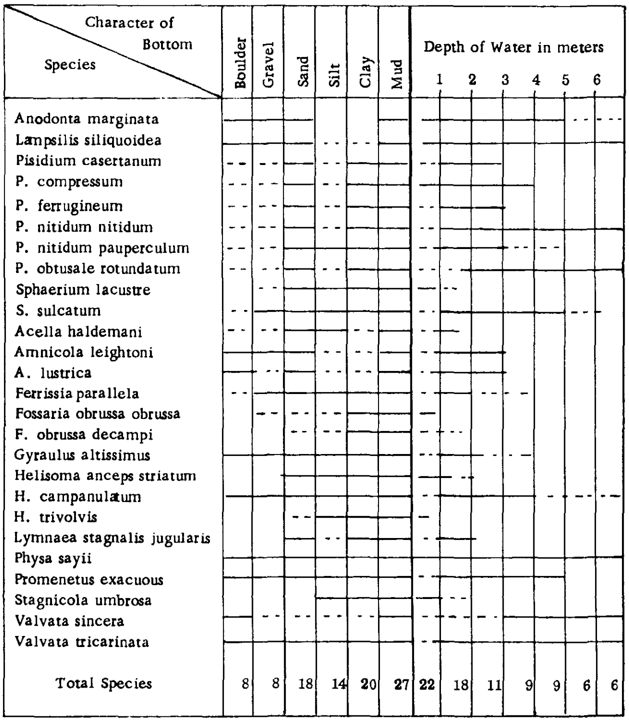

FIGURE 17. Relations of Mollusca to character of bottom and depth of water.

Vallonia pulchella (*Müller*).—This species lives under dead grass in crevices in stones, in moss under stones, boards, and dead wood, and after a rain, often appears in enormous numbers in localities where it has become established (Leonard 1950, p. 53). It has adapted itself to the environmental conditions established by the white man, and is probably now far greater in numbers than in the older heavily forested days. (Goodrich 1932, p. 10).

DISCUSSION

The molluscan assemblage of the collections at Station 1 is entirely fresh water with the exception of *Hawaiia minuscula*. The absence of a peat layer within the marl would indicate the presence of a permanent body of water throughout the period of deposition. This condition is confirmed by the average environmental conditions of the indigenous species.

Examination of figures 17 and 18 reveals the following are the optimum conditions for the fauna at Station 1. Bottom; mud, clay, or sand; water: 0.1 to 3 m deep, calm, clear; pH 7.6 and fixed carbon dioxide 13.0 ppm. Such an environment obviously did not persist throughout the period of deposition, nor is it assumed that all of these conditions occurred together at any one time. It is highly likely, however, that these conditions did obtain during the greater part of the time of development of the deposit.

The above inferences may be drawn from the specific assemblage of the deposit alone. Analysis of the quantitative and volumetric data throughout the several collections and comparison with the specific assemblage of these separate collections reveals the more discrete details of the environmental history.

Figure 2 lists the volumetric data and the estimates of the total Mollusca in a 12 x 12 x 2 in. layer for each collection. Figure 19 illustrates the relationship of the volume of the Mollusca to the volume of the other organic material. It is seen from the graph that an overall direct relationship exists between the two. Since the total Mollusca are a function of the volume and the volume of shell fragments remains relatively uniform, with the exception of collections 3 and 2, comparisons illustrated in figure 19 may be considered to be between the molluscan population and the amount of vegetation in each collection. Beginning with collection 23 and proceeding upward, an analysis of the environment of Station 1 may be made.

Collections 23 through 18 show an overall increase in both the total population and the amount of vegetation. Such a trend is expected in accordance with the conclusions of Dawson (1911, p. 29): 1. Where the pond weeds have captured quiet waters, no snails, alive or dead were found. 2. Snails live in moderate numbers where there is luxurious growth of weeds, if there be a considerable depth of water above the plants or if the water is gently flowing over them. 3. The snails occur in the greater numbers where there is a moderate amount of water plants and organic debris.

If the water were gradually becoming more shallow, the vegetation would most likely increase at the site and the population would increase. That the water was becoming more shallow is indicated by the absence of *V. sincera*, a deep water species, which is present in the marl below collection 23, and by the increase of *G. altissimus*, *A. lustrica*, and *A. leightoni*. As discussed previously (p. 17) *V. tricarinata* shows a slight increase in total numbers.

Collections 17 through 14 exhibit a wide fluctuation in vegetation, accompanied by a relatively steady decrease in total population. *V. tricarinata* and *G. altissimus* show a decrease in the same collections, whereas other species, *P. exacuous*, *A. leightoni*, *H. anceps striatum*, and *A. haldemani* increase. The general changes noted in these collections suggest fluctuations in the water level and corresponding unstable environmental conditions with a trend towards a shallow, quiet, protected environment necessary for the existence of *Acella*.

An examination of collections 13 through 7 reveals an increase in both the amount of vegetation and the total population. *V. tricarinata* remains relatively unchanged and *G. altissimus* increases slightly. *F. obrussa decampi* increases greatly. *A. lustrica* and *A. leightoni* decrease in percentage, but increase in actual numbers. *P. nitidum* and *P. ferrugineum*, and the Naiades show an increase. *Ferrissia parallela* makes its only appearance in these collections. These changes reflect the increase in vegetation and suggest a continual trend toward shallower water, almost swampy conditions.

The most significant change throughout the deposit occurs in collection 11. There is a great increase in the amount of vegetation and a marked increase in the total population (see fig. 19). *Acella haldemani* attains its maximum numbers, and *F. obrussa decampi* exhibits a great increase in number. The Naiades are greatly increased and three additional species, *Pseudosuccinea columella*, *Lymnaea stagnalis jugularis*, and *Fossaria obrussa* appear.

These distinct changes, particularly in the specific assemblage, suggest a sudden lowering of the water level causing the shoreline to migrate toward the Station sufficiently to allow the great increase in vegetation. The shoreline was, however, not close enough to allow choking of the waters which might affect other species. Also, the appearance of the additional species, their very limited numbers, and their disappearance in the very next collection suggests that the water probably did not remain at this low level for very long.

From collections 7 upward through collection 1 there is a great increase both in vegetation and in total population. At the same time there is a general decrease in the relative percentages of the less significant species, whereas *G. altissimus*, *A. leightoni*, and *A. lustrica* increase. *V. tricarinata* decreases slightly in percentage but shows little change in total numbers. *P. columella*, *L. stagnalis*, and *F. obrussa* reappear.

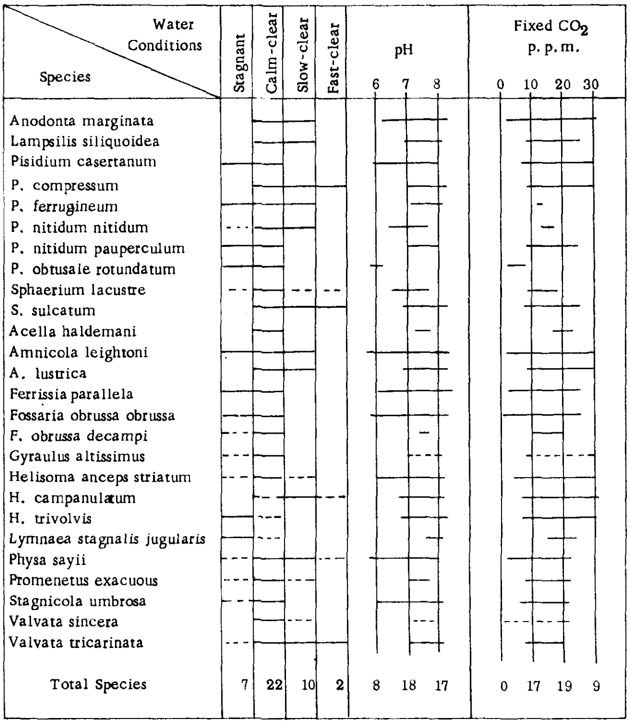

FIGURE 18. Relation of Mollusca to water conditions.

Collections 3 and 2 have a total population and amount of vegetation which are far greater than those of any other collection. This disproportion is best explained by the migration of the shoreline through the Station, accompanied by an accumulation of beach drift. It is noted in figure 2 that the ratio of shell fragments to vegetation in these collections greatly exceeds that of other collections. The changes in the specific assemblage along with the changes in vegetation and population indicates a steady lowering of the water level, corresponding migration of the shoreline through the Station, and ultimate disappearance of the lake from that particular site. The total vegetation would continue to increase but with a change from waterweeds to terrestrial vegetation. The appearance of *Hawaiia minuscula* supports this conclusion. The period during which the shoreline was present at Station 1 is represented by collections 3 and 2, where, in addition to the indigenous population, there was considerable accumulation of shells and shell fragments as beach drift. Such an accumulation indicates that the prevailing winds were from the northwest.

The steady lowering of the level of the lake would result in the transition from a freshwater environment directly to a terrestrial environment without the development of swampy conditions. The absence of a peat layer and of those species more typical of a swampy environment show that this was the case. Since there is a gradual but continuous slope from the margins of the lake through Station 1 toward the site of the present lake, it is not expected that swampy conditions would have developed.

At Station 2 the upper surface is approximately at the same level as the upper surface of Station 1. This area, however, represents a broad, flat embayment,

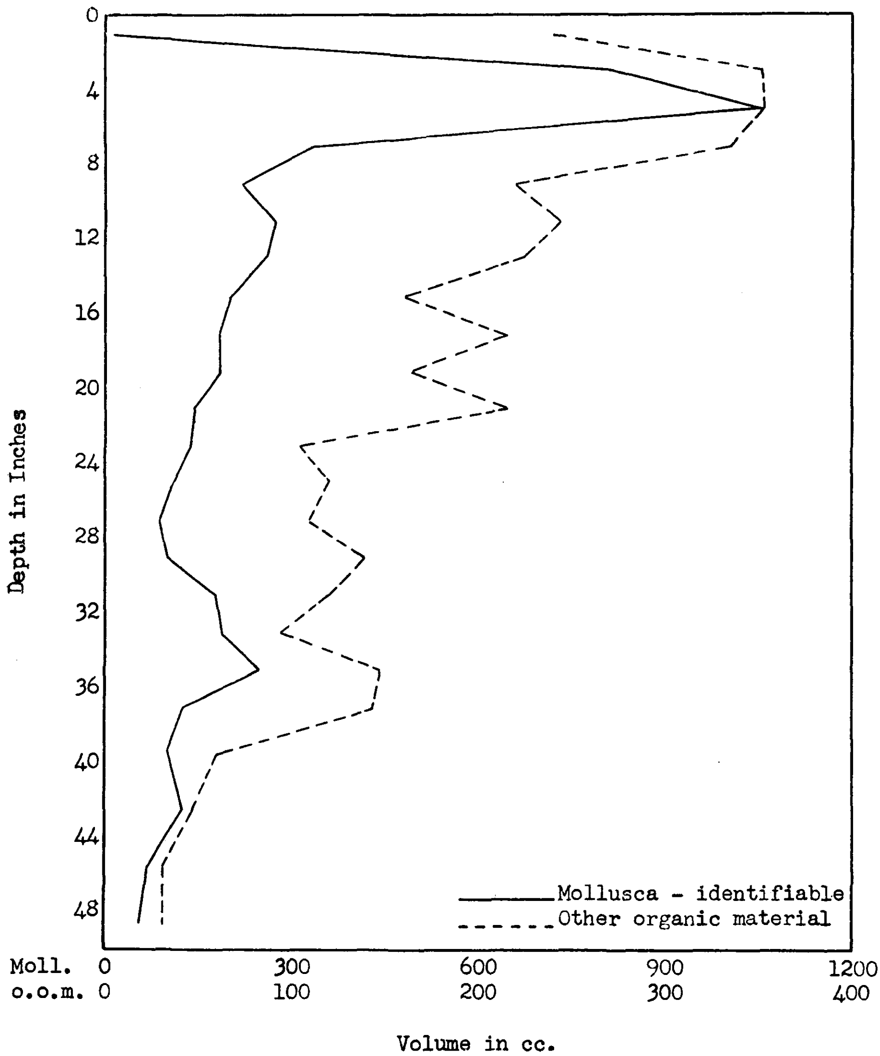

FIGURE 19. Graphic representation—vertical variation of Mollusca and other organic material in the Newell Lake deposit.

lacking the slope just discussed for Station 1. The lowering of the level of the water would result in shallow conditions which would extend over the entire embayment and most likely segregate the embayment from the main body of the lake. Thus, swampy conditions might be expected to develop. The much thicker layer of humus and the presence of peat at Station 16 (fig. 2), the appearance of such species as *Stagnicola umbrosa*, *Helisoma trivolvis*, *Succinea ovalis*, and *Pomatiopsis cincinnatiensis*, definitely point to a swampy environment. The presence of land snails at Station 2 indicates a continual presence of moist conditions, whereas at Station 1 only a single specimen of *Hawaiia minuscula*, a species which will survive under dry conditions, further proves the lack of low, moist, swampy conditions at Station 1.

AGE AND CORRELATION

General Statement

A comparison of the fauna studied with other faunas, both living and fossil, provides further understanding of the environment and some insight into the relative age of the Newell Lake deposit. Several representative faunas have been chosen in which the assemblage approximates that of the fauna at Station 1. In each list, the nomenclature has been brought up to date.

Living Fauna

North Star Lake, Itasca County, Minnesota.—The molluscan fauna collected by Baker (1935) from North Star Lake show a marked similarity to that of Pleistocene Newell Lake. In his discussion he states, "It is believed by the writer that many of the fossil faunas of the Illinoian Pleistocene especially in the loess deposits, lived under conditions comparable to those now found in northern Minnesota and southern Canada." In addition to the living fauna, *Gyraulus altissimus* was collected from the marl in Little North Star Lake. Several terrestrial species were also listed of which *Oxyloma retusa* was found along the shore.

North Star Lake is a deep glacial lake with rapidly descending shores. Molluscan life in the lake is largely within the 2 meter contour and practically ceases at the 4 meter contour. The list consists of the following species.

Anodonta kennicotti Lea
Anodonta marginata Say
Anodontoides modestus (Lea)
Lampsilis siliquoidea (Barnes)
Lampsilis siliquoidea rosacea (DeKay)
Sphaerium sulcatum (Lamarck)
Sphaerium truncatum (Linsley)
Pisidium sp.
Valvata tricarinata (Say) (111)
Amnicola limosa porata Say
Amnicola walkeri Pilsbry
Amnicola lustrica decepta F. C. Baker
Lymnaea stagnalis jugularis Say
Bulimnea megasoma (Say)
Acella haldemani ("Deshayes" Binney)
Fossaria obrussa decampi (Streng)
Helisoma anceps striatum (F. C. Baker)
Helisoma trivolvis macrostomum (Whiteaves)
Helisoma campanulatum (Say)
Planorbula armigera (Say)
Promenetus exacuous (Say)
Gyraulus deflectus obliquus (DeKay)
Gyraulus parvus (Say)
Gyraulus altissimus (F. C. Baker)
Gyraulus crista (Linnaeus)
Ferrissia parallela (Say)
Ferrissia fusca (C. B. Adams)
Physa gyrina Say
Oxyloma retusa Lea

Pleistocene Faunas

Rush Lake, Logan County, Ohio.—Baker (1920) describes the fauna collected by Dr. M. M. Leighton from Rush Lake as post-Wisconsin in age and concludes " . . .the Ohio deposit may, therefore, be considered as having lived in a larger Rush Lake, perhaps not long after the ice had disappeared from Ohio."

This fauna is of particular interest from the standpoint of its proximity, its age, the area of collection within the deposit, and the similarity of the fauna.

The shells were obtained from an exposure in an artificial ditch which drains into the lake a situation almost identical with Station 1 in the Newell Lake deposit. The list of species is:

Anodonta sp.—fragments
Sphaerium lacustre (Müller)—a dozen odd valves
Sphaerium sulcatum (Lamarck)—abundant
Pisidium casertanum (Poli)—2 valves
P. compressum Prime—common, almost abundant
P. ferrugineum Prime—a score
P. nitidum Jenyns—the most abundant species of the Sphaeriidae
P. nitidum pauperculum (Sterki)—2 valves
P. variabile Prime—about as common as *P. compressum*
Valvata sincera (Say)—3 specimens out of 20,000
V. tricarinata (Say) (111)—one of the most abundant species
V. tricarinata (Say) (101)—about 10 percent of the carinate *Valvata*
V. tricarinata (Say) (100)—a single specimen
Amnicola walkeri Pilsbry—not common, about 50 in a quart of material
A. leightoni F. C. Baker—with *A. lustrica* the most abundant species
A. lustrica Pilsbry—with *A. leightoni* nearly 40 percent of the total
Stagnicola palustris (Müller)—a single broken specimen
Fossaria obrussa decampi (Streng)—quite common
Helisoma anceps (Menke)—a fairly abundant species
H. anceps striatum (Baker)—about 10 percent of the *H. anceps*
Gyraulus altissimus (F. C. Baker)—after *A. lustrica* and *A. leightoni* is one of the most abundant shells in this deposit
G. deflectus (Say)—3 adult individuals
G. hirsutus (Gould)—a single specimen
Promenetus exacuous (Say)—fairly common
Ferrissia parallela (Haldeman)—a single specimen
Physa anatina Lea—adults not common, immature shells are almost abundant.

University of Illinois, Urbana, Illinois.—The fauna of this deposit occurs in marl overlying glacial till of Early Wisconsin age. Baker (1918b) states ". . . the relation of this marl to the till suggests that the pond or lake may have been inhabited by the mollusks when the late Wisconsin ice was resting at the Valparaiso moraine. . . . The fauna from these marls also indicates a cooler climate when the pond was occupied by the living mollusks, the southern limit of distribution of several of the species now being at considerable distance north of the locality." Baker's annotated list of species follows.

Sphaerium rhomboideum Prime—a portion of one right valve
Sphaerium occidentale Prime—one valve
Sphaerium lacustre (Müller)—a single valve
Pisidium nitidum Jenyns—the most abundant mollusk of the marl
P. ferrugineum Prime—next to *P. nitidum* is the most abundant
P. obtusale C. Pfeiffer—a few small specimens
P. variabile Prime—one valve
P. adamsi affine Sterki—a single valve
Valvata sincera (Say)—quite common
V. tricarinata (Say)—not common
Stagnicola reflexa (Say)—very abundant and variable
S. caperata (Say)—numerous, mostly mature
Fossaria obrussa decampi (Streng)—common

Helisoma trivolvis Say—not common, majority of individuals are immature
Gyraulus parvus urbanensis Baker—occurred sparingly
G. altissimus—a few adult individuals and a number of young and immature specimens
Physa sayii Tappan—a single immature shell
P. gyrina (Say)—occurs in abundance; the greater number are immature.

McKay Lake, Ottawa, Ontario, and Colton Lake, Renfrew County, Ontario.—The lists of species of these two deposits show similarities to the Newell Lake deposit. Whittaker (1921) places these deposits as recent and states that the deposit of McKay Lake appears to be much older than that of Colton Lake. The fossil lists are:

Colton Lake	McKay Lake
Pisidium casertanum (Poli)	*Pisidium casertanum* (Poli)
P. compressum Prime	. . . .
Valvata sincera (Say)	. . . .
V. tricarinata (Say)	*Valvata tricarinata* (Say)
Amnicola limosa Say	*Amnicola limosa* Say
A. leightoni F. C. Baker	*A. leightoni* F. C. Baker
A. lustrica Pilsbry	. . . .
. . . .	*Fossaria galbana* (Say)
. . . .	*F. obrussa* (Say)
Fossaria obrussa decampi (Streng)	. . . .
. . . .	*Helisoma anceps* (Menke)
Helisoma campanulatum (Say)	*H. campanulatum* (Say)
Gyraulus altissimus (F. C. Baker)	*Gyraulus altissimus* (F. C. Baker)
G. deflectus (Say)	. . . .
Physa gyrina Say	*Physa gyrina* Say
. . . .	*Stenotrema monodon* (Rackett)
. . . .	*Triodopsis albolabris* Say
. . . .	*Anguispira alternata* (Say)
Helicodiscus parallelus (Say)	*Helicodiscus parallelus* (Say)
. . . .	*Succinea ovalis* Say

CONCLUSIONS

The age of the Newell Lake deposit can be placed as Wisconsin on the basis of age assignments of the faunas compared and by the presence of such extinct species as *Amnicola leightoni*, *Helisoma anceps striatum*, *Gyraulus altissimus*, and *Fossaria obrussa decampi*. *G. altissimus* is extinct in Ohio but may be living farther north. Similarly *F. obrussa decampi* is extinct in Ohio but occurs in North Star Lake, Minnesota, and other northern lakes.

The presence of outwash, north and south of Newell Lake, covered with till of late Wisconsin age (in the usage of Goldthwait and Forsyth; see La Rocque and Forsyth, 1957, p. 81, footnote) suggests the earliest date for the development of the initial lake stage to be late Wisconsin, probably at a time when the ice was standing at the Farmersville moraine. The sharp drop of the bottom at Station 12 (fig. 3) could have been the result of a plunge pool developed at the ice margin.

As the ice retreated, sedimentation was continuous and the clay layer was deposited and filled the basin. Development of the outlet would have resulted in the lowering of the lake level and the opening of the lake to drainage westward. This lowering of the level resulted in the development of the peat layer overlying the clay. The presence of Naiades in this peat layer suggests the opening of the outlet, allowing fish to migrate upstream to the lake. Examination of material from the peat layer yielded confirmatory fish scales and a single vertebra. This layer provides the first record of molluscan life in the deposit. With the advent of Mollusca and the establishment of lime secreting plants such as *Chara*, deposition of the marl commenced and has proceeded to the present.

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